unwearied industry to the collection and comparison of the Cephalopods of the Lias, and at length, after some forty years of preparation, began his great monograph on "The Lias Ammonites," a work of much research, of which the concluding part is about to be issued, and which forms an enduring landmark in the history of English palæontology. In the course of the inquiries rendered requisite for this exhaustive treatise, he not only made himself acquainted with the fossil localities and public and private collections in this country, but paid visits to many parts of the Continent to study the contents of foreign museums and to confer with his fellow-labourers in the same field scattered over France, Switzerland, and Germany. He was engaged, at the time of his death, upon a monograph of British Cretaceous Starfishes, which he had nearly completed.

The value of his scientific work has been fully recognised by his contemporaries. He was early elected as a Fellow of the Royal Society of Edinburgh. Subsequently he joined the Geological Society of London, and from that body eventually received its highest honour—the Wollaston Medal. In 1879 he was elected into the Royal Society. He was President of the Geological Section of the British Association at the Bristol meeting in 1875. His published papers and memoirs are numerous, but the largest and most important are his monographs in the publications of the Palæontographical Society.

It was not alone by original research that Dr. Wright strove to foster the progress of his favourite science. As one of the fathers of the Cotteswold Field Club, as President of the Literary and Philosophical Association of Cheltenham, as a frequent lecturer on scientific topics not only in Cheltenham, but in Bristol, Bath, Worcester, and other towns; and generally by the enthusiasm with which, amid all the obstacles of his busy professional life, he contrived to find leisure for the cultivation of science, he was unquestionably one of the living forces that stimulated the growth of science all over the West of England. His death is therefore a serious deprivation, and will be mourned by all in that region to whom scientific progress is dear.

To a narrower but still a wide circle his removal from among us is the loss of a leal-hearted friend. Those who were thus privileged will cherish the memory of that cheery face with the bright twinkle of eyes that were as brimful at one time of merriment as, at another, they were suffused with sympathy; the joyous laughter that rang out clear and strong from a heart in which there was no guile; the earnest brow and hand upturned behind the ear as the talk went on over his favourite pursuits; the bursts of enthusiasm as some new fact or novel deduction dawned on him, and the play of humour that was ever ready to break out like a beam of summer sunshine. Dr. Wright made his final expedition in August last year, when he joined the writer of these lines in the Island of Arran. Already the symptoms of his fatal malady had shown themselves, and he knew what they foreboded. But he carried with him nevertheless his characteristic sunniness of nature. Seated on the bare mountain-side with the purple heather and yellowed bracken around him, the sea in front, and his own native Renfrewshire hills in the blue distance, he became almost a boy again as he told his reminiscences of old times and watched the sports of children among the gray boulders. Ripe in honours as in years, it seemed as if he had come back to his early northern air to drink it once more, and review his past before he should quit us for ever. He would saunter for hours in the quiet glen, with no companion but his own thoughts and the sights and sounds of Nature, which were an ever-gushing fountain of pleasure to him. Cherished is every memory of him, but most of all those parting days spent with him at the foot of the mountains and by the shore of the restless sea.

A. G.

ROBERT A. C. GODWIN-AUSTEN, F.R.S.

In many respects Mr. Godwin-Austen stood out apart from his fellow-geologists in this country. He wrote comparatively little, but what he did write was always weighty and full of suggestiveness. Instead of loading the literature of science with a pile of little papers, each containing some trifling addition or supposed addition to the sum of knowledge, or some criticism well- or ill-founded of the work of others, he allowed his ideas to mature, and published them from time to time in luminous essays which many years afterwards may be read over again with profit as well as pleasure. He began to write about half a century ago, his earliest papers being devoted to the geological features of Devonshire, of which, at that time, very little was known. By degrees he extended the area of his observations eastwards into the south-eastern counties. His essays "On the Valley of the English Channel" (1850), and "On the Superficial Accumulations of the Coasts of the English Channel, and the changes which they indicate" (1851), were among the most thoughtful contributions that had ever been made to the elucidation of the existing outlines of sea and land. This department of inquiry was one that peculiarly fascinated him. Hence, when his friend Edward Forbes died and left his "Natural History of the European Seas" only half completed, he himself chivalrously finished it, and supplied some chapters which only an accomplished and far-sighted geologist could have written. His various papers on drift-gravels, on boulders in the Chalk, and other superficial phenomena, are all marked by the same grasp and breadth of treatment.

But perhaps the paper which has chiefly contributed to give Mr. Godwin-Austen his ascendency among English geologists and to make his name known beyond geological circles is his now well-known essay "On the Possible Extension of the Coal-Measures beneath the South-Eastern Part of England" (1855). In this remarkable memoir he brings to bear his detailed knowledge of the rocks of the south-west of England, the north of France, and the adjoining tracts of Belgium. He marshals all his facts in such a way as to enable us, as it were, to strip off the thick cover of Mesozoic formations and trace the deep-seated connection of the Palæozoic area of Southern England and the Continent. At the time when he wrote, nothing was actually known of the subject, but he predicted that a submerged Palæozoic ridge would be found extending from the south-west of England into France and Belgium. The results of the deep borings of recent years have fully verified this prediction.

Mr. Godwin-Austen, in his prime, was a frequent speaker at the meetings of the Geological Society, where his keen penetrative criticism and caustic sarcasm formed a prominent and valuable feature in the debates. Some of his most suggestive and pregnant views of geological questions were thrown off in the course of these debates, and were never otherwise published by him. He never courted publicity, but rather shrank from it as an incumbrance under which he would not willingly be fettered. For many years past he has lived as a retired country squire at his beautiful residence near Guildford, taking full interest in the progress of science, and glad to see his fellow-workers in geology under his roof, but seldom venturing into the turmoil of town and the disputatious atmosphere of learned societies. It is some consolation to geologists, who mourn the quenching of one of their luminaries, that his place is taken by a son who, by scientific labours in India and in this country, has proved himself a worthy successor.

CHARLES CLOUSTON

The Rev. Chas. Clouston, LL.D., of Sandwick Manse, near Stromness, who died on the 10th ult. at the very advanced age of eighty-four years, was a man who

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deserves more than a passing notice in our columns. To name one only of his many claims to scientific recognition, he commenced meteorological observations in Stromness in the year 1822, and continued them, either there or in the adjacent parish of Sandwick, to within a fortnight of his death in 1884.

He belonged to the old Norse stock in Orkney, coming from the township of Clouston in Stennis. Two families of this name now live in the township, having succeeded to their farms, by direct descent, for over 400 years. He studied in Edinburgh University, and had at first been destined for the medical profession. He became a Licentiate of the R.C.S. in Edinburgh in 1819, and at his death was probably the father of the College. When in 1826 he entered on his duties as assistant and successor to his father, in the combined parishes of Stromness and Sandwick, there was no medical man in the latter place. For nearly fifty years he acted as the local doctor, in addition to his clerical duties, giving advice and medicines *gratis*. His father had been minister of Stromness for over sixty years, so that father and son had kept up a continuous ministry for 120 years. He received the degree of LL.D. from the University of St. Andrew's many years ago.

In the year 1862 Dr. Clouston's reputation as a careful meteorological observer was so well established that Admiral FitzRoy intrusted to his charge an anemometer, which has been kept in constant operation for the space of twenty-two years. The original instrument was replaced by a new one in 1869. A discussion of the results of the first five years' records (1863-68) appeared in the *Quarterly Weather Report* for 1871. In addition to his regular observations and deductions therefrom, which he occasionally published, he wrote an essay, "An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles," which gained the prize allotted by the Marquis of Tweeddale in 1867. His observations for the last thirty years, at least, have been regularly published by the Registrar-General for Scotland.

Dr. Clouston was not only a meteorologist, but an ardent follower of every branch of science which came in his way. In his "Guide to the Orkney Islands," a reprint of a portion of "Anderson's Guide," he modestly says, "Taking the Orkney Flora, as Dr. Neill left it, to include 462 specimens, and adding our own contribution of 156, it now contains 618 species." In archæology he took an active part in the exploration of Maes How, and the House of Skaill, both of them within a walk of his home.

Dr. Clouston leaves a widow, two sons, and two daughters, but more than one member of his family passed away before him. In conclusion, we can only say that a visit to Sandwick was ever a rare treat; the warm hospitality of the manse, and the interest of the conversation carried on round the table, could not fail to leave an impression which will not easily wear away.

ON THE AUTUMNAL TINTS OF FOLIAGE

AFTER the fine display of autumnal tints which we have lately seen it may, I trust, be of interest to some of the readers of NATURE if I give an account of the chief conclusions to which I have been led by carefully studying the subject for many years.

As a general rule the colour of leaves in their normal condition depends on a variable mixture of two perfectly distinct green pigments and of at least four perfectly distinct yellow substances. The development of the autumnal tints is mainly due to the disappearance or change of the green constituents and to the production of highly-coloured pigments by the oxidisation of previously existing very pale or colourless substances. It is, in fact, due to a more or less complete loss of the vitality which previously counteracted these chemical changes, and the order in which the tints are developed can be easily explained, if we assume that the death of the leaves takes place somewhat gradually. The first visible effect of the reduced vitality is the change in the green pigments. In many cases they appear to be converted into colourless products, since the resulting bright yellow leaves differ from the normal green in the absence of chlorophyll, and merely contain the usual previously-existing yellow pigments. At the same time it is quite possible that an increased quantity of some of these yellow substances may be formed as a product during the change, but of this there is no positive proof. In the case of such trees as the alder, the chlorophyll does not thus disappear, but is changed by the presence of a weak acid into a very stable brownish-green product which resists further change. The production of bright yellows or dull browns thus clearly depends on whether the chlorophyll does or does not disappear before being modified by the action of acids, as may be verified experimentally by exposing suitable solutions to sunlight. It is, however, very clear that the manner in which it changes depends very much on the conditions of the case. Thus, if chlorophyll is exposed to sunlight dissolved in bisulphide of carbon, a reddish-coloured product is formed, and though this differs very greatly from the red pigment met with in many autumnal leaves, it seems probable that under some conditions the chlorophyll in leaves is changed by the action of light into a red substance. By taking green sorrel leaves and keeping them somewhat fresh by sticking the stalks into moist ground, I found that those exposed to the sun with the under side upwards turned to a bright red, whereas those kept in the shade did not develop any fine colouring. We may often see that partially broken leaves or twigs undergo this change when all other parts of the tree remain green, and this and various other facts lead me to conclude that the change of chlorophyll into a red product depends on a certain amount of reduced vitality as well as on little-understood conditions varying in different kinds of plants. Though I fully admit that there are some facts not easy to understand, yet on the whole it seems to me that these principles fairly well explain why certain leaves turn red in autumn. Slight frosts reduce their vitality in such a manner that the chlorophyll is changed by the action of the light into a red product. Thus, according to the character of the season and the nature of the plants, the first effect of the reduced vitality in the leaves is that the chlorophyll is removed so as to show their normal yellow colour, or is changed into a red pigment, or is altered into a comparatively stable dull brown green product. These are the three extreme changes, but in many cases intermediate mixed results give rise to such less perfect and well-marked tints as dirty yellows and reds.

The next series of changes is best studied in the case of those leaves which in the first instance turn to a bright yellow, and it appears to me that they depend mainly, if not entirely, on the production of deeply-coloured pigments by the oxidisation of tannic acid and other more or less colourless substances. The difference in the resulting tint seems to depend on the nature of these substances. Thus, for example, the tannic acid in the yellow oak leaves changes into a brown substance, whereas the quinotannic acid in yellow beech leaves changes into the fine orange-brown colour which makes those trees so ornamental in autumn. On the contrary, the bright yellow poplar leaves rapidly pass to a dark dirty brown by the alteration of another constituent. Other kinds of leaves give rise to tints of an intermediate and less well-marked character. In many cases it is almost impossible to draw the line between the colour of this stage in the change and the final dark and dirty browns of dead and decaying leaves. For fine effect very much depends upon the production of each special tint in a fairly pure state, so as to show bright yellows, reds, and browns. This seems to be influenced by the character of the weather.

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